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NOTES.

“THE INADEQUACY OF NATURAL SELECTION.”

In view of the vital interest which the Philosophy of Evolution must have in maintaining the doctrine that characteristics acquired during the life-time of the individual can be transmitted to his descendants, a summary of Mr. Spencer's spirited defense of this bulwark of his system against the attacks of Professor Weismann may not be out of place in a philosophical journal. According to Professor Weismann, as every one now knows, the development of an organism through successive generations into a more complex form is due entirely to the occurrence of chance variations in the reproductive cells, the germ-plasm. Those variations which result in alterations of the mature organism tending to fit it more perfectly for its environment, are preserved by natural selection. *All* the work of evolution is thus done by natural selection. It is not possible for the reproductive or germ-cells to be affected in any way by the body-cells of the parent. According to the older view, natural selection is aided in the work of evolution by the assumed fact that the effects of use upon an organ to strengthen and perfect it may be transmitted to the next generation, thus producing an adaptation of the species to its environment much more rapidly than natural selection alone, acting upon accidental variations in the reproductive cells, could do. Moreover, the older theorists maintained, the effects of disuse of an organ in the life of an individual, are inherited, and thus a disused organ tends to degenerate much more rapidly than natural selection alone would make it; while Professor Weismann and his followers have substituted for the inheritance of the effects of disuse as a cause of degeneration, a principle known as ‘Panmixia.’ This term simply designates the alleged fact that, when an organ ceases to be useful, *i.e.*, ceases to be preserved by natural selection, it *ipso facto* degenerates, because those accidental variations in the germ-plasm which produce individuals, having the organ in question defective, are no longer eliminated by natural selection. The whole controversy, then, amounts to this: Are natural selection and panmixia able to account for all the phenomena for which the inheritance of acquired characteristics (*i.e.*, the effects of use and disuse) has hitherto been held responsible? A ‘previous question’ is, of course: Can the independence of body-cells and germ-cells which Weismann assumes be proved? The arguments brought forward on this point will not be discussed here. The first gun was fired by Mr. Spencer in his article, “The Inadequacy of Natural Selection,” in the *Contemporary Review* for February, 1893. He followed this by a second with the same title in the *Contemporary Review* for March. In the April number of the same periodical, Mr. Romanes, who, while believing in the in-

heritance of acquired characters, is an advocate of the reality of the principle of panmixia, or cessation of natural selection, criticised Mr. Spencer's attitude. Another criticism by Alfred Russel Wallace appeared in the *Fortnightly* for the same month. Mr. Spencer replied in the May *Contemporary*, by attacking Weismann afresh and replying to Romanes and Wallace, as well as to a less important criticism by E. Ray Lankester, in *Nature* for Feb. 23. In the *Contemporary* for July, Romanes reiterated his chief criticism on Mr. Spencer's misunderstanding of the term 'Panmixia,' and Mr. Spencer replied in an appended note. Then Professor Weismann himself took up the cudgels in two articles entitled "The All-sufficiency of Natural Selection" (*Cont. Rev.*, Sept. and Oct. 1893), to the latter of which Mr. Romanes added a 'last word' in his own dispute. Mr. Spencer published "A Rejoinder to Professor Weismann" in December, 1893. The next declaration of Professor Weismann's views was in his Romanes Lecture given at Oxford, May 2, 1894, on "The Effect of External Conditions on Development," and to this Mr. Spencer responded by summing up his case in "Weismannism Once More" (*Cont. Rev.*, Oct. 1894).

I. Mr. Spencer's first argument is from the variations on different parts of the skin in the ability to discriminate between stimuli applied close together. As is well-known to psychologists, this discriminativeness varies widely, being greatest on the tongue and finger-tips and least on the back. Mr. Spencer contends that these differences cannot have been developed by natural selection, since natural selection can only preserve such variations as are of life-saving importance. The fact that the discriminativeness is greatest on those parts which are most used for active touch, shows that the variations are due to the inherited effects of use and disuse. Romanes answers: (*a*) these differences may have been life-saving to our quadrumanal ancestors; (*b*) there is no evidence to prove that the differences are congenital, and not the result of individual use. [There is such evidence. Czermak found that individual practice, as shown in the greater sensibility of blind people, produced no more effect upon the parts most used than upon other parts.] To these arguments Mr. Spencer does not reply. Mr. Wallace says that local discriminativeness of the skin is the least part of dermal sensibility in general, and dermal sensibility in general is greatest, not on those parts which are most used, but on those which are most exposed to injury, hence the variations have been produced by natural selection, and not by use-inheritance. Mr. Spencer denies that differences in general sensibility have originated by natural selection alone. Professor Weismann does not take up the argument further than to adopt Mr. Romanes' suggestion, that the sensibility of the tongue-tip may have been of use to certain ancestral primates. Mr. Spencer demands in return why this discriminativeness, having lost its usefulness, has not long since been eliminated by panmixia.

II. Mr. Spencer's second argument is an attack on the principle of panmixia. He interprets it as meaning that, when an organ is no

longer useful, those chance-variations in germ-plasm which produce individuals with the organ in question defective, are preserved by natural selection because they imply a saving of nutrition. And he points out that the saving of nutrition involved at each step of the degeneration would be far too minute to be life-saving, hence could not be preserved by selection. Romanes answers that this is a confusion of panmixia, which is the cessation of selection, with quite another principle, that of negative selection by economy of nutrition. Mr. Spencer denies that he has misunderstood Weismann here. Romanes quotes passages from Weismann to show that the two principles are regarded as distinct; and explains panmixia more fully as follows. There is always an excess of minus variations, that is, of variations tending to *reduce* the development of an organ, over the plus variations, tending to increase its development. Now, while natural selection acts, — while the organ is useful, — these excessive minus variations are eliminated. So soon as the organ ceases to be useful, the excessive minus variations are allowed to develop and perpetuate themselves, and the organ degenerates. Mr. Spencer at once inquires why there should be this original excess of minus over plus variations. Mr. Romanes responds — very briefly, several months later — (1) that the excessive minus variations may be caused by reversion, and (2) that when selection is withdrawn, 'the failures in the force and precision of heredity will be allowed to survive.' Just before this, Professor Weismann had corroborated Romanes' position that panmixia and selection by economy of nutrition were quite distinct, and stated his belief that the latter principle is unimportant, while acknowledging that the process of panmixia must be very slow. Mr. Spencer still demands an explanation of the assumption that the minus variations of a disused organ are in excess of the plus variations, instancing the case of the whale, which has lost its hind limbs. Why should the minus variations have been predominant in an animal whose growth in size since it became a water-animal shows an habitual excess of nutrition; and why should these minus variations have been transmitted to offspring if natural selection was inoperative? The only possible explanation is that the effects of disuse have been inherited.

III. In the third place, Mr. Spencer argues, how are we to account for the harmonious development of coöperative parts on the hypothesis of natural selection of chance variations? There are three conceivable suppositions regarding chance variations of coöperative parts, *e.g.*, the parts of a limb. (1) They may occur in like degrees for each part. This is obviously contrary to fact; witness the great variety of existing adjustments. (2) They may occur in such a way as to bring about the desired adaptation. This contradicts the supposition that they are *chance* variations. (3) They may occur with absolute independence for each part. This is the only allowable hypothesis. Now, in order that, *e.g.*, the North American prairie-dog, used to a level surface, shall become adapted to leaping, at least fifty different parts in each hind leg must be altered, not to mention

necessary changes in the fore-legs. How long, according to the law of probabilities, would it be before chance would bring about simultaneous variations in all these parts? And the variations must be simultaneous, for one change is useless without the others, and would not be preserved by natural selection long enough for the others to arise.

Mr. Romanes grants the force of this argument. Professor Weismann answers, first: Because use-inheritance is the simplest explanation for the adaptation of coöperative parts, it is not necessarily the true one. Use-inheritance cannot cause the development of an organ, for degeneration is not caused by inheriting the effects of disuse, as is shown by the fact that *inactive* structures, *e.g.*, the armature of the crab, degenerate when no longer serviceable. To this Mr. Spencer rejoins, first, that "an argument derived from degeneracy of passive structures scarcely meets the case of development of active structures," and second, that he has "never dreamed of denying the efficiency of natural selection as a cause of degeneracy in passive structures" which are injurious to the race. Professor Weismann's second answer is more elaborate. He points out that very complicated variations of coöperating parts do take place where there is no chance for the inheritance of acquired characteristics; for instance, in the neuters of bees and ants, which are produced by parents unlike themselves, and do not themselves have offspring. The degeneration of sexual organs and other parts which we see in these 'workers' must be the result of panmixia; where there is no offspring there can be no inherited effects of disuse. Similarly, the development of the brain and other organs in the workers, is a good instance of coöperative variations in germ-plasm without use-inheritance. Moreover, some species of ants have two kinds of workers, one of which must have sprung from the other — as is shown by the existence of numerous intermediate grades — at a time when the sterility of the workers was well established, and use-inheritance out of the question. Again, in slave-making ants we have the workers losing — by panmixia — their instinct to search for food, and becoming adapted to make war on tribes which furnish slaves — another excellent example of coadaptation without use-inheritance.

Mr. Spencer rejoins, first, that we cannot argue about characteristics developed during the social or organized state without knowing the characteristics which existed in the original state of these insects. The characteristics of the workers and soldier-ants, though not inherited from the queen-mother, are very likely inherited from pre-social ancestors. Moreover, in the case of ants with two kinds of workers, between which there exist numerous intermediate forms, how does it happen that natural selection has preserved for so many generations these 'injurious deviations from the useful extreme forms'? Lastly, the process by which simultaneous chance variations can have arisen to produce the worker-types remains inconceivable.

In his Romanes Lecture Professor Weismann offers another explanation of the simultaneous adaptation of coöperative parts, by suggesting that it is

due to 'intra-individual selection' — to the fact, namely, that there is a struggle for nutriment between different parts of the body, those parts which are doing most work obtaining most food. But, Mr. Spencer inquires: Are the effects of this struggle transmissible? Certainly not, according to Weismann; they are acquired characteristics. Professor Weismann, however, argues that the potentialities in germ-plasm for this adjustment by intra-selection are operated on by natural selection: that is, those germs which have potentialities for a perfect intra-selective adaptation are best fitted to survive. Mr. Spencer again asks: How do these potentialities in germ-plasm arise, if not by that 'fortuitous concurrence' of variations whose inconceivability has been demonstrated?

Moreover, Mr. Spencer maintains that the production of neuters among social insects does not result from original differences in germ-plasm, but from supplying the germs with poorer nourishment. Professor Weismann objects that this difference in nutrition is not the *cause* of the different forms of the workers, but the *stimulus* which calls into activity original germ-differences. He has attempted to prove this by taking larvae of the blow-fly, and feeding some abundantly, and others sparingly. All the resulting insects had perfect reproductive organs: therefore, scanty feeding cannot cause degeneration of the reproductive organs. Mr. Spencer replies (1) that the differences in feeding should have been in *quality*, not merely in *quantity* of food, and (2) that experiments on the blow-fly are irrelevant, as its reproductive organs are doubtless formed relatively earlier than those of social insects, and would hence be less affected by feeding. Mr. Spencer then points out difficulties which Professor Weismann's hypothesis of 'determinants' must encounter in explaining the great variety of forms among social insects; and the argument from adaptation of coöperative parts is closed, having gone, one must acknowledge, chiefly against the new theory.

One more consideration, introduced by Professor Weismann himself, must be noticed. The fact that the little toe in man is degenerating has, he says, been explained by the inherited effects of boot-pressure. This is manifestly absurd, as the degeneration is found among savages. Panmixia is the true cause. On the contrary, rejoins Mr. Spencer, we have here an excellent example of the inherited effects of disuse, since the little toe has long been useless in supporting the body.

As before indicated, the evidence brought forward in this controversy for or against Weismann's fundamental position that the reproductive cells are not influenced by the body-cells, will not be discussed. It is at this point, undoubtedly, that the defense is weakest. If you ask, 'Can it be shown that acquired characteristics are inherited?' one must answer that it is very difficult to do so in particular cases. On the other hand, can we explain the facts of evolution without assuming such inheritance? The arguments summarized above show that such a task is practically impossible.

Emeritus Professor Campbell Fraser is at present delivering the Gifford Lectures at Edinburgh University. These will be published shortly in book form by Blackwood & Sons.

The REVIEW has received the first number of a new psychological periodical, the *Psychologische Studien*, edited by Professor Kraepelin, of Heidelberg. Its purpose is to show the applicability of the methods and results of the new psychology to psychiatry. The opening number contains: (1) an article on *The Psychological Experiment in Psychiatry*, by the editor; (2) *Experimental Studies in Individual Psychology*, by A. Oehrn (practically a reprint of a Dorpat dissertation for the philosophical doctorate, published in 1889); (3) a paper dealing with the *Modification of Simple Conscious Processes by Mental and Physical Work*, by S. Bettmann. These will be given in summary later.

Mention of the death of Carl Krille, the Leipsic mechanician, was omitted from the March REVIEW from lack of space. Those who knew the old Leipsic Institute will have heard the news with regret. It was impossible to help liking Krille himself, and the good quality of his earlier work must atone for the poorness of construction of many of his more recent instruments. The new mechanician of the Institute is E. Zimmermann (Emilienstrasse 21), formerly a colleague of the unapproachable Baltzar, and a thoroughly good workman.

William Caldwell, M.A., D.Sc., formerly Instructor in the Sage School of Philosophy, has been called to fill the chair of Ethics and Social Philosophy, which has recently been established at Northwestern University.